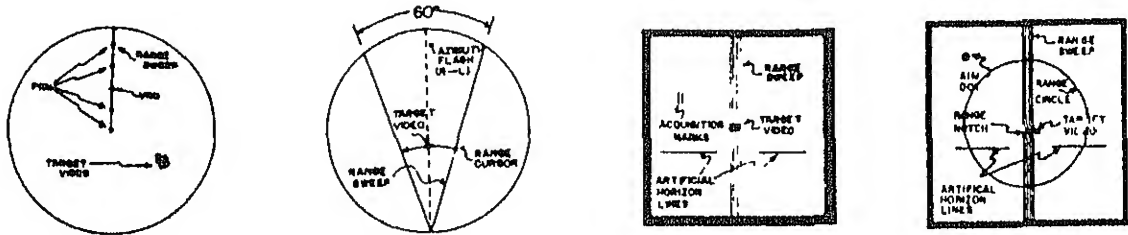


# ASSIGNMENT BOOK

FOR

## ADVANCED FIRST-TERM AVIONICS COURSE

CLASS A1 -  
C-100-2010



## UNIT VI

CNTT- M1697

PREPARED BY  
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PREPARED FOR  
CHIEF OF NAVAL TECHNIAL TRAINING

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## FOREWORD

The purpose of this Assignment Book is to provide you with the assignments, minor enabling objectives, and instructions for each lesson contained in Unit VI. The proper use of this book will aid you in retaining the information presented during this unit of instruction. This knowledge will aid you in future training conducted in this course and while performing your duties in the fleet environment.

The table of contents lists page numbers of each assignment and the homework schedule will tell you when each assignment is due.

## SAFETY NOTICE

As a Navy electronics technician, you will be required to perform safe and efficient maintenance on various types of equipment. Not only your life, but the lives of many others depend on your being safety conscious at all times. It is the responsibility of all Navy and Marine Corps personnel to prevent accidents. You, as a technician must realize that it is your responsibility to know and practice all correct maintenance procedures.

SAFETY CAN NEVER BE OVERSTRESSED!!!!!!

## HOW TO USE THIS ASSIGNMENT BOOK

This Assignment Book has been provided for you to use while you attend the Advanced First-Term Avionics Course (Class A1). Ample space has been provided for all homework assignments and any additional notes you may desire to insert. Remember that all homework is MANDATORY.

This book contains the following:

1. All assignments necessary to accomplish the Unit VI objectives.

GOOD LUCK!!!!!!!

## UNIT VI CLASS SCHEDULE

Unit VI is two weeks long and starts the afternoon of the fifth day of the tenth week. The periods run from 397 to 476, with the last period ending halfway through the fifth day of the twelfth week.

The schedule is as follows:

TOPIC NO.	TYPE	PERIOD	TOPIC
TENTH WEEK			
Fifth Day			
6.1	Class	397 398 399 400	Introduction to Airborne Radar
ELEVENTH WEEK			
First Day			
6.2	Class	401 402 403	Radar System Analysis
6.3	Class	404 405	Low-voltage Power Supplies
6.4	Class	406	High-voltage Power Supplies
6.5	Lab	407 408	Operational Modes of the 11D13A Radar Trainer
Second Day			
6.6	Class	409 410 411	Synchronizer Block Analysis
6.7	Class	412 413 414 415 416	Synchronizer Circuit Analysis

TOPIC NO.	TYPE	PERIOD	TOPIC
Third Day			
6.8	Class	417	Transmitter Block
		418	Analysis
6.9	Class	419	Transmitter Circuit
		420	Analysis
		421	
		422	
6.10	Class	423	Test Equipment and
		424	Operation
Fourth Day			
6.11	Lab	425	Synchronizer and Trans-
6.12		426	mitter Lab
		427	
		428	
6.13	Class	429	Receiver Block and IF
		430	Amplifiers
6.14	Class	431	Receiver Gain Control
		432	
Fifth Day			
	Class	433	Unit/Module Test: Crit-
		434	erion Test/Written Exam-
		435	ination
		436	
6.15	Class	437	Receiver AFC Circuit
		438	
		439	
		440	
TWELFTH WEEK			
First Day			
6.16	Class	441	Synchro Fundamentals
		442	
		443	
		444	
		445	
6.17	Class	446	Servo Fundamentals
		447	
		448	

TOPIC NO.	TYPE	PERIOD	TOPIC
Second Day			
6.18	Class	449	Synchro Resolvers
6.19	Class	450	Display Correlation
		451	
		452	
6.20	Lab	453	Display Correlation
		454	Lab
		455	
		456	
Third Day			
6.21	Class	457	Range Track Block
		458	Diagram
		459	
		460	
6.22	Class	461	Range Track Schematic
		462	Analysis
		463	
		464	
Fourth Day			
6.23	Class	465	Angle Track Analysis
		466	
6.24	Class	467	Radar Indicators
		468	
6.25	Lab	469	Range Track Checks
		470	
		471	
		472	
Fifth Day			
	Class	473	Unit/Module Criterion
		474	Test/Written
		475	Examination
		476	

## UNIT VI HOMEWORK SCHEDULE

Homework is MANDATORY! In Unit VI, homework is assigned as each lesson topic is covered. Homework is due on the morning following the lesson completion day. Each assignment sheet will be checked by an instructor for correctness and completion. Information sheets assigned with lesson topics are also considered as homework. Failure to complete assigned homework can result in disciplinary action.

Assignment Sheet	Period Due
6.1.1A	401
6.2.1A	409
6.3.1A	409
6.4.1A	409
No Assignment Sheet	
6.6.1A	417
6.7.1A	417
6.8.1A	425
6.9.1A	425
6.10.1A	425
6.13.1A	433
6.14.1A	433
6.15.1A	441
6.16.1A	449
6.17.1A	449



# Assignment Sheet

Period Due

6.18.1A

457

6.19.1A

457

6.21.1A

465

6.22.1A

465

6.23.1A

473

6.24.1A

473

## UNIT LEARNING OBJECTIVES

### MINAL OBJECTIVES

- 0 ISOLATE an instructor-induced malfunction (under limited supervision) in an avionics RADAR training device to a weapons replaceable assembly, a shop replaceable assembly, a stage, and a component and record results on job sheets. Test equipment will be provided. Performance must be accomplished in accordance with the Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Volumes I and II, NAVEDTRA P-2974-1. All general and personnel safety precautions must be observed in accordance with OPNAVINST 5101.2 (series).

### BLING OBJECTIVES

- 1 EXTRACT troubleshooting and performance data from given block and schematic diagrams of an avionics RADAR training device. All circuit performance and operating characteristics will be documented on job sheets in accordance with specifications contained in the Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Volumes I and II, NAVEDTRA P-2974-1.
- 2 PERFORM visual inspections on an avionics RADAR training device for physical defects, integrity, and proper installation and RECORD results on a job worksheet. Performance must be accomplished in accordance with procedures outlined in the Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Volumes I and II, NAVEDTRA P-2974-1.
- 3 PERFORM operational and minimum performance checks (under limited supervision) on an avionics RADAR training device and RECORD results on job data sheets provided. Performance must be accomplished in accordance with the Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Volumes I and II, NAVEDTRA P-2974-1. All safety precautions must be observed in accordance with OPNAVINST 5101.2 (series).
- 4 ISOLATE an instructor-induced malfunction (under limited supervision) on an avionics RADAR training device to a weapons replaceable assembly, a shop replaceable assembly,

a stage, and a component, and RECORD results on job sheets. Test equipment will be provided. Performance must be accomplished in accordance with the Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Volumes I and II, NAVEDTRA P-2974-1. All safety precautions must be observed in accordance with OPNAVINST 5101.2 (series).

## ASSIGNMENT SHEET 6.1.1A

### INTRODUCTION TO AIRBORNE RADAR

#### INTRODUCTION

The purpose of this assignment is to familiarize you with the two basic types of radar, the way an individual may determine target information, and the elements of a radar set. It is important, first, to know the basic principles and then to know when and how to modify them.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.1.1. SELECT, from a given list, the information that is obtained from both continuous wave and pulse modulator radar systems.
- 12.1.2. SELECT, from a given list, the major factor that determines the maximum range of a radar.
- 12.1.3. SELECT, from a given list, the major factor that determines the minimum range of a radar.
- 12.1.4. SELECT, from a given list, the carrier frequency of most airborne radar systems.
- 12.1.5. SELECT, from a given list, the elements that make up a basic airborne radar.
- 12.1.6. SELECT, from a given list, the characteristics of a search radar.
- 12.1.7. SELECT, from a given list, the characteristics of a bomb-director radar.
- 12.1.8. SELECT, from a given list, the characteristics of a fire-control radar.
- 12.1.9. SOLVE, given basic radar specifications, for unknown values of operating parameters.

## STUDY ASSIGNMENT

1. Read Aviation Fire Control Technician 3 & 2, NAVEDTRA 10387-B, pages 235-263.
2. Review Notetaking Sheet 6.1.1N.
3. Read Information Sheet 6.1.1I.
4. Review Film Guide 6.1.1F.
5. Complete Assignment Sheet 6.1.1A.

## STUDY QUESTIONS

1. CW radar is capable of detecting what information?
  - a. Altitude
  - b. Range
  - c. Speed
  - d. Bearing
2. One radar range mile is equal to
  - a. 6.18 microseconds
  - b. 12.36 milliseconds
  - c. 6.18 milliseconds
  - d. 12.36 microseconds
3. Search radars commonly use \_\_\_\_\_ radar sets.
  - a. continuous wave
  - b. amplitude modulated
  - c. pulse modulated
  - d. deflection modulated
4. Most fire control radars operate in the range of
  - a. 10,000 khz
  - b. 1,000 mhz
  - c. 1,000 khz
  - d. 10,000 mhz

5. A given radar set has a pulse width of 2 microseconds, and a pulse repetition frequency of 1,000 hertz. The duty cycle is
- a. .0002
  - b. .02
  - c. .002
  - d. .2
6. What is the formula for duty cycle?
- a.  $DC = PW \div PRF$
  - b.  $DC = PW \div PRT$
  - c.  $DC = PW \times PRT$
  - d.  $DC = PRF \div PW$
7. The heart of the radar system is the
- a. Transmitter
  - b. Receiver
  - c. Synchronizer
  - d. Display
8. What is the primary controlling factor of maximum range?
- a. Pulse width
  - b. Sensitivity
  - c. Gain
  - d. Pulse repetition frequency
9. What is the duplexer used for?
- a. Switching of the transmitter and receiver
  - b. Amplifying low amplitude target returns
  - c. Protects the components in the transmitter
  - d. Amplification of the transmitted energy



## ASSIGNMENT SHEET 6.2.1A

### RADAR SYSTEM ANALYSIS

#### INTRODUCTION

The purpose of this assignment is to familiarize you, and to learn, the presentations displayed in the various modes and submodes of operation. Once the purposes of each block have been identified, and the inputs and outputs understood, you may begin a logical block by block study until a thorough understanding of this radar system is mastered.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.3.1. SELECT, from a given list, the purpose of each of the basic units of the 11D13 Radar Trainer.
- 12.3.2. SELECT, from a given list of symbols, those symbols present in the PPI mode of operation.
- 12.3.3. SELECT, from a given list of symbols, those symbols present in the bomb director mode of operation.
- 12.3.4. SELECT, from a given list of symbols, those symbols present in the fire control mode of operation.

#### STUDY ASSIGNMENT

- 1. Read pages 3-1 through 3-73 of the 11D13A Maintenance Handbook, NAVTRADEV P-2974-1.
- 2. Review Information Sheet 6.2.1I.
- 3. Review Notetaking Sheet 6.2.1N.
- 4. Complete Assignment Sheet 6.2.1A.

#### STUDY QUESTIONS

- 1. The primary purpose of the synchronizer is to
  - a. generate all timing signals.
  - b. turn on the indicators.
  - c. fire the transmitter.
  - d. provide range marks for the fire control indicator.



2. The master trigger is sent to the \_\_\_\_\_  
and \_\_\_\_\_ units and to the target generator.
3. The purpose of the transmitter is to
4. The purpose of the indicator display unit is to
5. The purpose of a duplexer is to
6. The input that fires the transmitter is
  - a. the master trigger.
  - b. doppler gate.
  - c. the delay trigger.
  - d. time zero.
7. What is the purpose of the range track unit?
8. What are the 3 modes of operation for the 11D13 Radar Trainer?
  - a.
  - b.
  - c.

ASSIGNMENT SHEET 6.3.1A  
LOW-VOLTAGE POWER SUPPLIES

INTRODUCTION

The purpose of this assignment is to provide you with a review of low-voltage power supplies, transistor biasing, and regulating power supplies. The completion of this assignment will aid you in identifying half-wave rectifier power supplies, conventional full-wave rectifier power supplies, conventional full-wave rectifier power supplies, regulated power supplies, and tracking current flow through power supply circuitry.

LESSON TOPIC LEARNING OBJECTIVES

- 12.4.1. SELECT, from a list, a low voltage, half-wave rectifier power supply's purpose, characteristics, and circuit operation.
- 12.4.2. SELECT, from a list, a conventional full-wave rectifier's purpose, characteristics, and circuit operation.
- 12.4.3. SELECT, from a list, the power supply regulator's purpose, characteristics, and circuit operation.
- 12.4.4. SELECT, from a list, the biasing of a transistor required for Class A operation.
- 12.4.5. SELECT, from a list, the biasing of a transistor required for Class B operation.
- 12.4.6. SELECT, from a list, the biasing of a transistor required for Class C operation.
- 12.4.7. SELECT, from a list, the transistor regulated power supply's (1600 unit) purpose, characteristics, and circuit operation.

## STUDY ASSIGNMENT

1. Review Notetaking Sheet 6.3.1N.
2. Complete Assignment Sheet 6.3.1A.

## STUDY QUESTIONS

1. Why are two series diodes used in a half-wave rectifier?
  - a. To increase the MPIV rating
  - b. For full-wave rectification
  - c. For current handling capability
  - d. Less ripple is produced
2. In the regulated vacuum tube power supply, what is the purpose of V-227?
  - a. A comparator
  - b. An amplifier
  - c. A voltage regulator
  - d. A current regulator
3. In the regulated vacuum tube power supply, what is the function of C-252A?
  - a. Coupling
  - b. Filtering
  - c. Phase shifting
  - d. Pulse stretching
4. Why are two dual tubes used as the series regulator?
  - a. Better isolation
  - b. Better amplification
  - c. More voltage out
  - d. Better current handling
5. In the regulated vacuum tube power supply, what is the purpose of V226A and B?
6. What are the components that provide the filtering for the full-wave rectifier V-218?

7. Which transistor is the series regulator in the synchronizer power supply?
  - a. Q1632
  - b. Q1628
  - c. Q1631
  - d. Q1630
8. In the 1600 unit power supply, what are the output voltages?
  - a. +25Vd-c
  - b. -2Vd-c
  - c. -25Vd-c
  - d. +2Vd-c
9. In the 1600 unit power supply, which resistor controls the output?
10. In the 1600 unit power supply, what components make up the rectifier circuits?
11. In the 1600 unit power supply, what keeps the negative voltage on the collectors of Q-1628 and Q-1629?
  - a. F1601
  - b. T1601
  - c. Q1631
  - d. R1632
12. Explain forward bias of a PNP transistor's emitter-base circuitry.
13. Explain reverse bias of a PNP transistor's collector-base circuitry.



## ASSIGNMENT SHEET 6.4.1A

### HIGH-VOLTAGE POWER SUPPLIES

#### INTRODUCTION

The purpose of this assignment sheet is to reinforce the basic concepts taught in this lesson. Specific topics covered are voltage doublers and RF voltage amplifiers. Pay very close attention to figures 2 and 4 of Notetaking Sheet 6.4.1N and be sure you can readily identify the circuits.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.8. SELECT, from a list, the statements that describe the Voltage Doubler's purpose, characteristics, and circuit operation.
- 12.4.9. SELECT, from a list, the statements that describe the RF Oscillator's purpose, characteristics, and circuit operation.

#### STUDY ASSIGNMENT

- 1. Read Section 3 of the Maintenance Handbook, Device 11D13A, NAVTRADEV P-2974-1, Dec. 1968, pages 3-53 and 3-54.
- 2. Review Notetaking Sheet 6.4.1N and then answer the following questions.

NOTE: Refer to figure 2 of Notetaking Sheet 6.4.1N when answering questions 1-4 and refer to figure 4 of Notetaking Sheet 6.4.1N when answering questions 5-9.

- 3. Complete Assignment Sheet 6.4.1A.

## STUDY QUESTIONS

1. What is the purpose of R723 and R724?
  - a. Bleeder resistors
  - b. Load resistors
  - c. Current limiters
  - d. Voltage divider
2. What is the purpose of a bleeder resistor?
  - a. Equipment safety
  - b. Develop the output
  - c. Less power loss
  - d. Personnel safety
3. What pins of L702 form the primary winding?
  - a. 1 and 2
  - b. 3 and 4
  - c. 4 and 5
  - d. 3 and 5
4. V706's feedback signal is \_\_\_\_\_.
  - a. The voltage developed by R725 and filtered by C712
  - b. The signal coupled to L702, pins 1 and 2
  - c. Coupled through C713 and C714 to the grid
  - d. RC coupled through C713 and C714 to the cathode
5. C713, C714, and L702,, pins 4 and 5, comprise what type of circuit?
  - a. A parallel resonant tank
  - b. A colpitts oscillator
  - c. A pi-section LC filter
  - d. A phase-shifting network
6. What component adjusts the 4,000 volt output?
  - a. V706
  - b. C713
  - c. L702
  - d. R728
7. What is the 4,000 volt output used for?
  - a. Aquadag voltage
  - b. Intensity and focus controls
  - c. B+ for the CRT's
  - d. Applied to the cathode of the CRT's

8. What is the purpose of the voltage doubler output?
  - a. Applied to the aquadag coating
  - b. Focus and intensity control
  - c. Special circuit operation
  - d. Keeps the CRT's ionized
9. How are the filaments of V707 heated?
  - a. Applied a-c voltage
  - b. Applied d-c voltage
  - c. They are not heated
  - d. Induced RF energy





ASSIGNMENT SHEET 6.6.1A  
SYNCHRONIZER BLOCK DIAGRAM

INTRODUCTION

The purpose of this assignment is to familiarize you with the basic operation of the synchronizer. You will need to possess the knowledge of this material in order to progress into more complex circuitry. It is recommended that you also review your student guide for a refresher on special circuits which were taught in Unit Three.

LESSON TOPIC LEARNING OBJECTIVES

- 12.4.10. SELECT, from a list, the statement that best describes the purpose of the synchronizer unit.
- 12.4.11. SELECT, from a list, the statement that best describes the purpose, characteristics, and development of the basic trigger.
- 12.4.12. SELECT, from a list, the statement that best describes the delay trigger's purpose, characteristics and development.
- 12.4.13. SELECT, from a list, the statement that best describes the master trigger's purpose, characteristics and development.
- 12.4.14. SELECT, from a list, the statement that best describes the fixed range marks purpose, characteristics and development.
- 12.4.15. SELECT, from a list, the statement that best describes the sweep gate's purpose, characteristics and development.
- 12.4.16. SELECT, from a list, the statement that best describes the doppler gate's purpose, characteristics and development.
- 12.4.17. SELECT, from a list, the statement that best describes the purpose of the marks mixer.

## STUDY ASSIGNMENT

1. Read pages 3-12 through 3-26 of the Radar Maintenance Handbook, Device 11D13A, NAVTRADEV P.2974, December 1968.
2. Read AQ 3 & 2, pages 249, 264-270 and 317-320.
3. Review Notetaking Sheet 6.6.1N.
4. Complete Assignment Sheet 6.6.1A.

## STUDY QUESTIONS

1. What is the purpose of the synchronizer?
2. A 1618 and associated circuitry comprise a \_\_\_\_\_.
  - a. Free-running, single-cycle blocking oscillator
  - b. Free-running, Hartley oscillator
  - c. Triggered, single-cycle blocking oscillator
  - d. Twin-tee oscillator
3. The output frequency of the ringing oscillator is \_\_\_\_\_ kHz.
  - a. 16.18
  - b. 116.18
  - c. 61.18
  - d. 161.8
4. The delay multivibrator (Q1606 and Q1607) produces a \_\_\_\_\_ square wave whose pulse width is adjustable from \_\_\_\_\_ to \_\_\_\_\_ microseconds.
5. The range of the VRM is used for what?
  - a. Bearing
  - b. Approximate range
  - c. Precise range
  - d. Elevation

6. The PRF of the synchronizer reference oscillator is

\_\_\_\_\_.

- a. 1000 kHz
- b. 161.8 Hz
- c. 1000 Hz
- d. 161.8 kHz

7. What signal is present at J1612?

- a. Negative pulses, one microsecond duration, occurring at T0
- b. Positive pulses, one microsecond duration, occurring at T0
- c. Negative pulses, one microsecond duration, occurring at T1
- d. Positive pulses, one microsecond duration, occurring at T1



## ASSIGNMENT SHEET 6.7.1A

### SYNCHRONIZER CIRCUIT ANALYSIS

#### INTRODUCTION

The purpose of this assignment is to provide you with an understanding of the special circuits required for proper operation of the radar synchronizer. The synchronization of the radar system is a major requirement for accuracy of range and target determination. The material in this assignment will prove to be a cornerstone in the development of your abilities to troubleshoot complex radar systems.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.18. SELECT, from a given list, the statement that describes the basic trigger's circuit characteristics and operation.
- 12.4.19. SELECT, from a given list, the statement that describes the delay trigger's circuit characteristics and operation.
- 12.4.20. SELECT, from a given list, the statement that describes the master trigger's circuit characteristics and operation.
- 12.4.21. SELECT, from a given list, the statement that describes the range mark generator's circuit characteristics and operation.
- 12.4.22. SELECT, from a given list, the statement that describes the sweep gate's circuit characteristics and operation.
- 12.4.23. SELECT, from a given list, the statement that describes doppler gate's circuit characteristics and operation.
- 12.4.24. SELECT, from a given list, the statement that describes the marks mixer's circuit characteristics and operation.

#### STUDY ASSIGNMENT

- A. Read Section III, pages 3-12 through 3-25 in the Maintenance Handbook, Radar Maintenance Trainer, Device 11D13A, NAVTRADEV P-2974-1, December 1968.
- B. Read pages 249, 264-270, and 317-320 in NAVEDTRA 10387B, Aviation Fire Control Technician 3&2.
- C. Review notes on synchronizer schematic diagram.
- D. Read Information Sheet 6.6.11.

E. Complete Assignment Sheet 6.7.1A.

STUDY QUESTIONS

1. Name the two sections that make up the basic trigger's circuit.
  - a.
  - b.
2. What is the input signal and the output signal of the basic trigger circuit?
  - a.
  - b.
3. Name the five major component parts that make up the delay trigger circuitry.
  - a.
  - b.
  - c.
  - d.
  - e.
4. What is the input signal to the delay trigger generator?
  - a.
  - b.
5. What is the quiescent state of the delay multivibrator?
6. Name the two major component parts of the master trigger circuitry.
  - a.
  - b.
7. What is the input signal to the master trigger blocking oscillator and what is the output of the inverter (Q-1619)?
  - a.
  - b.

8. The range marks circuitry consists of three major sections. Name them.
  - a.
  - b.
  - c.
9. The range marker generator produces pulses indicating what three different range separations?
  - a.
  - b.
  - c.
10. What type of oscillator is Q-1612?
11. What are the three major component parts in the sweep gate circuitry?
  - a.
  - b.
  - c.
12. What is the output of inverter Q-1627?
13. What type of circuit is Q-1620 & Q-1621?
14. What is the signal output of the doppler gate circuitry?
15. What is the purpose of diode CR-1633?
16. What is the purpose of transistor Q-1626?
17. What triggers the marks mixer stage Q-1615?
18. What is the output of the marks mixer? (two conditions)
  - a.
  - b.





ASSIGNMENT SHEET 6.8.1A  
TRANSMITTER BLOCK ANALYSIS

INTRODUCTION

The purpose of this assignment sheet is to reinforce your basic knowledge of a radar transmitter. The radar transmitter provides a pulse with characteristics that determine minimum and maximum range, range resolution, and range accuracy. These characteristics are essential to the operator and to the technician.

LESSON TOPIC LEARNING OBJECTIVES

- 12.4.25.    SELECT, from a given list, the purpose of an airborne radar transmitter.
- 12.4.26.    SELECT, from a given list, the purpose of the modulator.
- 12.4.27.    SELECT, from a given list, the purpose of the trigger generator.
- 12.4.28.    SELECT, from a given list, the purpose of the directional coupler.
- 12.4.29.    SELECT, from a given list, the purpose of the duplexer.

STUDY ASSIGNMENT

- A.   Read Aviation Fire Control Technician 3&2 NAVEDTRA 10387-B, pages 270-279, 320-322, and 642-646.
- B.   Read Maintenance Handbook, Radar Maintenance Trainer, Devices 11D13 and 11D13A, NAVTRADEV P-2974-1, December 1968, Section III, pages 3-2 through 3-5.

- C. Read Information Sheet 6.8.1I.
- D. Complete Assignment Sheet 6.8.1A.
- E. Review transmitter block diagram.

#### STUDY QUESTIONS

1. What factor primarily determines the maximum range of a radar?
  - a. Pulse width
  - b. Pulse repetition frequency
  - c. Average power
  - d. Atmospheric conditions
2. What factor primarily determines the minimum range of a radar?
  - a. Pulse width
  - b. Pulse repetition frequency
  - c. Peak power
  - d. Pulse repetition time.
3. What type of modulation is the most common from fire control radar?
  - a. Continuous wave
  - b. Frequency modulation
  - c. Pulse modulation
  - d. Amplitude modulation
4. V102 is a cathode follower. What function does it provide in relation to V101 and V103?
  - a. Isolates V101 and V103 from the PFN.
  - b. Isolates V101 from V103.
  - c. Amplifies V101's output for V103.
  - d. Isolates V101 and V103 from the synchronizer circuits.
5. What is the purpose of the directional coupler?
  - a. Switches the antenna between transmit and receive
  - b. Attenuates the transmitted signal
  - c. Improves receiver sensitivity
  - d. Allows insertion and extraction of test signals.

6. The dummy load dissipates the transmitted RF energy in the form of \_\_\_\_\_.
7. When are the duplexer's TR tubes ionized?
- a. During transmit time
  - b. During receive time
  - c. When target returns are weak
  - d. When target returns are strong



## ASSIGNMENT SHEET 6.9.1A

### TRANSMITTER CIRCUIT ANALYSIS

#### INTRODUCTION

This assignment sheet has been prepared for your use to reinforce the concepts presented in the "Transmitter Circuit Analysis" lesson.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.30.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the transmitter's relay and control circuitry.
- 12.4.31.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the transmitter's low voltage power supply.
- 12.4.32.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the trigger generator.
- 12.4.33.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the modulator power supply.
- 12.4.34.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the modulator circuit.
- 12.4.35.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the magnetron.
- 12.4.36.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the RF duplexer.
- 12.4.37.     SELECT, from a given list of statements, the statement that describes the purpose, characteristics, and circuit operation of the waveguide.

## STUDY ASSIGNMENT

1. Read Maintenance Handbook, Radar Maintenance Trainer, Devices 11D13 and 11D13A NAVTRADEV P-2974-1, December 1968, Section III, pages 3-2 through 3-5.
2. Read Information Sheets 6.9.1I, 6.9.2I, and 6.9.3I.
3. Complete Programmed Instruction, M589, "Magnetrons".
4. Complete Programmed Instruction, M629, "Waveguides".
5. Complete Assignment Sheet 6.9.1A.
6. Review Film Guide 6.9.1F.

## STUDY QUESTIONS

1. A duplexer could be referred to as a/an
  - a. receiving device.
  - b. transmission line.
  - c. electronic switch.
  - d. transmitter.
2. The function of TR tubes is to protect the
  - a. transmitter.
  - b. waveguides.
  - c. receiver.
  - d. antenna.
3. What is the main purpose of a duplexer?
  - a. A protection device for the receiver
  - b. Transmission of RF energy
  - c. To increase receiver sensitivity
  - d. Allows the use of one antenna for both Tx and Rx functions
4. Keep-alive voltage applied to the TR tubes keeps them
  - a. sufficiently warm.
  - b. glowing.
  - c. deionized.
  - d. near ionization.
5. When the TR tubes are becoming defective, the first visual indication will be
  - a. loss of minimum-range targets.
  - b. loss of maximum-range targets.
  - c. smoke coming from the waveguides.
  - d. a bright spot on the CRT.

6. If faulty TR tubes are not recognized and replaced soon enough, this could result in
  - a. a defective antenna.
  - b. defective and arced waveguides.
  - c. weak targets displayed.
  - d. no targets displayed.
7. The wide dimension of a waveguide determines its \_\_\_\_\_.
8. The narrow dimension of a waveguide determines its \_\_\_\_\_.
9. When the TR tube is ionized, the waveguide is electrically
  - a. shorted.
  - b. open.
  - c. mismatched.
  - d. matched.
10. The RF phase shift thru a slot in a duplexer is
  - a.  $45^{\circ}$ .
  - b.  $60^{\circ}$ .
  - c.  $90^{\circ}$ .
  - d.  $120^{\circ}$ .
11. The wide dimension of a waveguide determines the
  - a. frequency.
  - b. power.
  - c. speed.
  - d. impedance.
12. (Device 11D13) The function of T-103 is to
  - a. control peak power out of V-105.
  - b. control voltage supplied to T-104.
  - c. control voltage supplied to Z-101.
  - d. all the above.
13. (Device 11D13) Z-101 is a/an
  - a. open-end transmission line.
  - b. shorted-end transmission line.
  - c. open-end artificial transmission line.
  - d. shorted-end artificial transmission line.



14. (Device 11D13) A function of L-101 is to allow the PFN to charge to approximately
- a. the voltage supplied the PFN.
  - b. twice the voltage supplied the PFN.
  - c. three times the voltage supplied the PFN.
  - d. four times the voltage supplied the PFN.
15. (Device 11D13) V-105 is a
- a. low-power, high-frequency device.
  - b. high-power, high-frequency device.
  - c. low-power, low-frequency device.
  - d. high-power, low-frequency device.
16. (Device 11D13) V-103 provides Z-101 with a
- a. fast discharge path during transmit time.
  - b. fast discharge path during rest time.
  - c. slow discharge path during transmit time.
  - d. slow discharge path during rest time.
17. (Device 11D13) M-102 monitors
- a. peak current.
  - b. average current.
  - c. peak voltage.
  - d. average voltage.
18. (Device 11D13) T-102 has a one-to-
- a. one ratio.
  - b. two ratio.
  - c. three ratio.
  - d. four ratio.
19. (Device 11D13) 250 volts is supplied to Z-101 by the modulator power supply. How much voltage is felt at the cathode of V-105 during transmit time?
- a. 250 volts.
  - b. 500 volts.
  - c. 1000 volts.
  - d. 2000 volts.

20. (Device 11D13) M-101 monitors

- a. V-103 plate current.
- b. V-104 cathode current.
- c. Z-101 charge current.
- d. Z-101 inverse current.

21. (Device 11D13) M-103 monitors

- a. output voltage of modulator power supply.
- b. voltage supplied to Z-101.
- c. V-104 cathode current.
- d. PFN charge.

22. Pulse width of a radar set is determined by the

- a. synchronizer.
- b. PFN.
- c. modulator power supply.
- d. switch tube.

23. In a given PFN, there are 4 identical sections. The "L" of each section is 2 henries. The capacitance of each section is 2 pF. The PW is

- a. 16 sec.
- b. 4 sec.
- c. 8 sec.
- d. 12 sec.



## ASSIGNMENT SHEET 6.10.1A

### TEST EQUIPMENT AND OPERATION

#### INTRODUCTION

The purpose of this assignment is to familiarize you with the various types of test equipment necessary to properly maintain a radar system. Once this has been learned, you can acquire some principles and techniques that are useful and important in specific circumstances.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.56. SELECT, from a given list, what happens to power out with an increase or decrease of 3 dBm.
- 12.4.57. SELECT, from a given list, what happens to power out with an increase of 10 dBm.
- 12.4.58. SELECT, from a given list, the amount of milliwatts that 0 dBm is equal to.
- 12.4.59. CONSTRUCT a dBm chart, using the three rules for constructing a dBm chart.
- 12.4.60. CALCULATE the average and peak power and the duty cycle of a radar system.
- 12.4.61. SELECT, from a given list of statements, the statement that describes the radar characteristics that can be determined with the use of the TS-757/UPM-32 Test Set.
- 12.4.62. SELECT, from a given list, the characteristics of a good spectrum of a transmitted pulse.

## STUDY ASSIGNMENT

### A. Reading assignment:

1. Aviation Fire Control Technician 3 & 2, NAVPERS 10387-B, Chapter 20, pages 601-6093, Chapter 22, pages 642-646.
2. Maintenance Handbook, Device 11D13A NAVTRADEV P-2974-1, December 1968, Section IV, pages 4-16, 4-17, Section V, pages 5-10 through 5-20, 5-116J, 5-116K, 5-117.
3. Read Information Sheets
  - a. 6.10.1I - "dBm Conversion"
  - b. 6.10.2I - "Tektronix 2336YA Oscilloscope"
  - c. 6.10.3I - "TS-757/UPM-32 Radar Test Set"
  - d. 6.10.4I - "Fluke 8000A Digital Multimeter"
  - e. 6.10.5I - "TDR and FDR Principles"

B. Review Notetaking Sheet 6.10.1N.

C. Complete Assignment Sheet 6.10.1A.

The following questions should be answered in the spaces provided.

### STUDY QUESTIONS

1. What happens to power if an increase of 3 dBm is obtained?
2. What happens to power out if power is increased by 10 dBm?
3. Convert 35 dBm to average power.
4. How does changing the resistance of the meter balance control change the balance of the power level bridge?
5. What are the five characteristics required to be checked in the spectrum analyzer operation?
  - a.
  - b.
  - c.
  - d.
  - e.

## ASSIGNMENT SHEET 6.13.1A

### RECEIVER BLOCK DIAGRAM AND IF AMPLIFIERS

#### INTRODUCTION

The purpose of this assignment is to familiarize you, the technician, with the receiver block diagram and IF amplifier circuitry. Once you are familiar with this circuitry, you will be able to quickly and efficiently troubleshoot the radar receiver. It is important, first, to know the basic principles and then to know when and how to modify them when necessary.

#### LEARNING OBJECTIVES

- 12.4.38. SELECT, from a given list of statements, the statements that describe the characteristics of a cascaded amplifier.
- 12.4.39. SELECT, from a given list of statements, the statements that describe the bandpass of the IF strip.
- 12.4.40. SELECT, from a given list of statements, the statements that describe the receiver power supply's purpose, circuit characteristics, and operation.
- 12.4.41. SELECT, from a given list, the purpose of CR-901.
- 12.4.42. SELECT, from a given list, the advantages of a balanced crystal mixer.
- 12.4.43. SELECT, from a given list, the statement that describes the relation between the transmitter frequency and the local oscillator frequency.
- 12.4.44. SELECT, from a given list of statements, the statement that describes a minimum discernable signal.
- 12.4.45. SELECT, from a given list of statements, the statement that describes the purpose, circuit characteristics, and operation of the receiver IF amplifiers.

## STUDY ASSIGNMENT

1. Read and study Chapter 11, pages 279 through 295 of the Aviation Fire Control Technician 3 & 2, NAVPERS 10387-B, and Section III, pages 3-5 through 3-7 of the Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, NAVTRADEV P-2974-1, Dec. 1968.
2. Read Information Sheet 6.13.1I "Radar Receivers".
3. Review Notetaking Sheet 6.13.1N.
4. Answer study questions on Assignment Sheet 6.13.1A.

## STUDY QUESTIONS

1. What section of a radar receiver should be rigidly controlled to maintain a good signal-to-noise ratio?
  - a. Second detector
  - b. Local oscillator
  - c. IF amplifiers
  - d. Preamplifier
2. By using a balanced crystal mixer in a radar receiver, noise generated by the \_\_\_\_\_ is greatly reduced.
  - a. magnetron
  - b. klystron
  - c. mixer
  - d. phanastron
3. What is the purpose of the cascode amplifier stage?
  - a. Amplifies the 30 MHz IF signal
  - b. Isolates the mixer from the IF amplifiers
  - c. Decreases the noise level
  - d. Filters out the RF oscillations
4. What is minimum discernable signal?
  - a. The smallest target that can be seen above the receiver's noise
  - b. The smallest target that can be detected at maximum range

## ASSIGNMENT SHEET 6.14.1A

### RECEIVER GAIN CONTROL

#### INTRODUCTION

The purpose of this lesson is to familiarize you with a basic knowledge and understanding of radar receiver gain control circuitry. Three special gain control circuits will be discussed, each being essential to the operator and technician.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.46. SELECT, from a given list of statements, the statements that describe the purpose, characteristics, and circuit operation of the Automatic Gain Control (AGC) circuits.
- 12.4.47. SELECT, from a given list of statements, the statements that describe the purpose, characteristics, and circuit operation of the Instantaneous Automatic Gain Control (IAGC) circuits.
- 12.4.48. SELECT, from a given list of statements, the statements that describe the purpose, characteristics, and circuit operation of the Sensitivity Time Control (STC).
- 12.4.49. SELECT, from a given list of statements, the statements that describe the Manual Gain Control Circuit's characteristics and operation.

#### STUDY ASSIGNMENT

- 1. Read Chapter 11, pages 288 through 293, Aviation Fire Control Technician 3 & 2, NAVPERS 10387-B.
- 2. Read Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, NAVTRADEV P-2974-1, Section III, pages 3-6 through 3-8.
- 3. Review Notetaking Sheet, 6.14.1N.
- 4. Complete Assignment Sheet 6.14.1A.

#### STUDY QUESTIONS

- 1. What is the purpose of AGC?
  - a. To detect all targets
  - b. To determine the relative size of targets
  - c. To detect the small targets
  - d. Increases the gain at an exponential rate after T1



2. What component sets the bias threshold for AGC?

- a. R245
- b. R248
- c. R232
- d. T901

3. What component sets the static operating level for AGC?

- a. R245
- b. R248
- c. R232
- d. T901

4. Why is IAGC used to detect all targets?

- a. With IAGC, target size can be distinguished.
- b. Each individual target return sets its own gain control.
- c. An average voltage is applied to the IF amplifier and is controlled by the average strength of return. The gain can be controlled manually by the operator.

The waveform used for SI is a \_\_\_\_\_.

- a. negative sawtooth with a sharp trailing edge
- b. positive sawtooth with a sharp leading edge
- c. negative sawtooth with a sharp leading edge
- d. positive sawtooth with a sharp trailing edge

## ASSIGNMENT SHEET 6.15.1A

### RECEIVER AFC CIRCUIT

#### INTRODUCTION

The purpose of the assignment is to familiarize you with basic AFC circuitry utilized in radar systems. Once you have an understanding of the special circuits and devices, you will become an effective technician. Keep in mind that it is important to first know the basic principle and then to determine when and how to modify the if necessary.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.50.      SELECT, from a given list, the purpose of the Automatic Frequency Control circuit.
- 12.4.51.      SELECT, from a given list, the methods of tuning a klystron.
- 12.4.52.      SELECT, from a given list of statements, the statements that describe the Automatic Frequency Control circuit.
- 12.4.53.      SELECT, from a given list, the purpose of the control amplifier (phantastron) circuit.
- 12.4.54.      SELECT, from a given list, the components that control the cycle and recycle time of the AFC control amplifier during AFC search operation.
- 12.4.55.      SELECT, from a given list of statements, the statements that describe the Weiss Discriminator's purpose, circuit operation and characteristics.

#### STUDY ASSIGNMENT

##### A. Reading Assignment:

1. Aviation Fire Control Technician 3 & 2, NAVPERS 10387-B, Chapter 11, pages 279-281, 293-295.
2. Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Device 11D13A, NAVTRADEV P-2974-1, December 1968, pages 3-9 and 3-10.
3. Basic Electronics, Volume II, NAVPERS 10087-C, CNTT-M699 PAT, Chapter 3, pages 53 through 58.

4. Information Sheet 6.15.1I "AFC and Local Oscillators".
- B. Review Notetaking Sheet 6.15.1N.
- C. Complete Assignment Sheet 6.15.1A.
- D. Complete Programmed Instructions, CNTT-623, "Klystrons". Answer the following questions. Write your answers in the spaces provided.

#### STUDY QUESTIONS

1. What is the purpose of the AFC circuitry?
  - a. Sets a high signal-to-noise ratio
  - b. Maintains a constant IF frequency
  - c. Allows size determination of targets
  - d. Detects received targets and puts out video
2. What is the function of V211?
  - a. AFC amplifier
  - b. Video amplifier
3. If the magnetron frequency increases, what does the AFC circuit do to the repeller plate voltage?
  - a. Makes it more positive
  - b. Makes it more negative
4. How can the greatest change in klystron frequency be accomplished?
  - a. Move buncher grids closer together
  - b. Make the repeller plate more negative
  - c. Move buncher grids further apart
  - d. Make the repeller plate more positive
5. What component sets the level or base frequency of the AFC search?
  - a. C235
  - b. C236
  - c. R292
  - d. R248

## ASSIGNMENT SHEET 6.16.1A

### SYNCHRO FUNDAMENTALS

#### INTRODUCTION

The purpose of this assignment is to give you a basic understanding of synchros. With the increased application of synchros in today's sophisticated airborne electronics equipment, it is necessary to have a thorough understanding of synchros to be an effective technician. The concepts discussed in this assignment will be the foundation for that understanding.

#### LESSON TOPIC OBJECTIVES:

- 12.4.63. SELECT, from a given list of statements, the one which describes the most important feature of a synchro.
- 12.4.64. SELECT, from a given list of synchro diagrams, the one which represents an electrical zero condition.
- 12.4.65. SELECT, from a given list of diagrams, the one which depicts a synchro transmitter and receiver at coincidence and, in the space provided, list the conditions of current in the stator winding.
- 12.4.66. SELECT, from a given list of statements, the one which explains the difference between a synchro transmitter and receiver.
- 12.4.67. SELECT, from a given list, the purpose of a differential synchro transmitter.
- 12.4.68. SELECT, from a given list of statements, the one which describes a transmitter and a receiver.
- 12.4.69. SELECT, from a given list, the purpose of a control transformer.
- 12.4.70. SELECT, from a given list of statements, the one which describes the difference between a control transformer and a receiver.
- 12.4.71. GIVEN the schematic diagram of a synchro system, compute the position of the receiver rotor for specified inputs.
- 12.4.72. CALCULATE the control transformer's output voltage for given synchro and differential positions.

## STUDY ASSIGNMENT

### A. Reading assignment:

1. Basic Electronics, Vol. II, NAVPERS 10087-C, M-669, Chapter 12, pages 197 through 223.
2. Aviation Fire Control Technician 3&2, NAVEDTRA 10387-B Chapter 6, pages 152 through 187.
3. Information Sheet No. 6.16.1I "'A' to 'B' Method for Simple Synchros".
4. Information Sheet No. 6.16.2I "Synchro Fundamentals".

### B. Review Notetaking Sheet 6.16.1N.

### C. Complete Programmed Instructions:

1. Simple Synchro Operation and Application, M-233 (Rev 2-71).
2. Differential Synchro Transmitter Operation & Application M-137 (Rev 4-71).
3. Synchro Control Transformers, M-100 (Rev 7-68).

### D. Complete Assignment Sheet 6.16.1A.

## STUDY QUESTIONS

1. The primary purpose of a simple synchro system is for the transmission of
  - a. angular information.
  - b. torque information.
  - c. angular and torque information.
  - d. trigonometric information
2. With 115 volts applied to the rotor of a synchro transmitter and the rotor positioned on  $45^\circ$ , which of the following is a true statement when  $R_1$  is maximum positive?
  - a. 78 volts will be read, positive to negative from  $S_1$  to  $S_3$ .
  - b. 87 volts will be read, positive to negative from  $S_2$  to  $S_1$ .
  - c. 87 volts will be read, negative to positive from  $S_2$  to  $S_1$ .
  - d. 52 volts will be read, negative to positive from  $S_3$  to  $S_1$ .

3. With standard connections between units and the transmitter positioned at  $060^\circ$ , where will the receiver be positioned?
  - a.  $300^\circ$ .
  - b.  $240^\circ$ .
  - c.  $120^\circ$ .
  - d.  $060^\circ$ .
4. With  $S_1$  and  $S_3$  reversed between the transmitter and receiver and with the transmitter positioned at  $150^\circ$ , where will the receiver be positioned?
  - a.  $150^\circ$ .
  - b.  $210^\circ$ .
  - c.  $030^\circ$ .
  - d.  $240^\circ$ .
5. A synchro transmitter is connected to a synchro receiver
  - a. mechanically.
  - b. magnetically.
  - c. directly.
  - d. electrically.
6. A synchro is comparable to a
  - a. single-phase transformer.
  - b. generator.
  - c. synchronous motor.
  - d. three-phase transformer.
7. Synchro transmitters and receivers are usually not interchangeable because
  - a. they are not electrically identical.
  - b. they are not mechanically identical.
  - c. the generator is larger than the motor.
  - d. the generator operates at a higher voltage.
8. Synchro systems will be at a null when induced emf's are
  - a. in phase and equal.
  - b. out of phase and equal.
  - c. in phase and not equal.
  - d. out of phase and not equal.

9. The windings of the synchro stators are displaced from each other by
- 45°.
  - 90°.
  - 120°.
  - 240°.
10. The rotor of a synchro must continuously draw current to
- produce heat.
  - maintain a magnetized rotor.
  - set up a reference voltage.
  - produce an induced voltage in the stators.
11. With the rotor leads to the receiver reversed, which of the following conditions would exist?
- The transmitter on 000° and the receiver on 000°.
  - The transmitter on 270° and the receiver on 150°.
  - The transmitter and receiver would turn in opposite directions.
  - The transmitter and receiver would turn in the same direction, with 180° displacement between the rotors.
12. When "zeroing" a synchro transmitter or receiver, which of the following conditions must exist?
- Zero volts from  $S_1$  to  $S_2$ .
  - Equal voltages from  $S_1$  to  $S_2$  and  $S_1$  to  $S_3$ .
  - Equal voltages from  $S_2$  to  $S_1$  and  $S_2$  to  $S_3$ .
  - Zero volts from  $S_1$  to  $S_3$  and  $S_3$  to  $S_2$ .
13. When using a synchro transmitter and receiver with standard connections, the receiver will follow the transmitter because the output information from the stators of the transmitter is
- the same for 360° of rotation.
  - the same only at the 090° points.
  - the same only at the 000° and 180°.
  - not repeated for 360° of rotation.
14.  $S_1$  and  $S_3$  leads are reversed between units and  $R_1$  and  $R_2$  are reversed at the receiver. The transmitter is positioned at 080°. The receiver will be positioned at
- 260°.
  - 100°.
  - 280°.
  - 130°.

15. With  $R_1$  and  $R_2$  reversed at the receiver and the transmitter positioned at  $074^\circ$ , the receiver will be positioned at
- a.  $074^\circ$ .
  - b.  $184^\circ$ .
  - c.  $254^\circ$ .
  - d.  $324^\circ$ .
16. The synchro operates on the principle of the
- a. transmitter.
  - b. transformer.
  - c. generator.
  - d. motor.
17. Inertia dampers are used on
- a. synchro transmitters.
  - b. synchro control transformers.
  - c. synchro receivers.
  - d. synchro differential generators.
18. In reference to synchros, what does the numeral-letter combination 23TR6 mean?
- a. 2.2 to 2.3 inches in diameter, torque receiver, 60 Hz.
  - b. 2.2 to 2.3 inches in diameter, torque unit, 60 Hz.
  - c. 2.2 to 2.3 inches in diameter, torque receiver, 6 Hz.
  - d. 2.2 to 2.3 inches in diameter, torque unit, 6 Hz.
19. With the rotor of the synchro transmitter at  $000^\circ$ , what is the voltage induced in  $S_2$ ?
- a. 55 volts
  - b. 52 volts.
  - c. 26 volts
  - d. 0 volts.
20. With the rotor of the synchro transmitter at  $240^\circ$ , what is the voltage induced in  $S_1$ ?
- a. 55 volts.
  - b. 52 volts.
  - c. 26 volts.
  - d. 0 volts.



21. With  $S_1$  and  $S_3$  reversed between the transmitter and differential,  $R_1$  and  $R_3$  reversed at the differential with the differential positioned at  $200^\circ$ , and the receiver positioned at  $060^\circ$ , where must the synchro transmitter be positioned?
- a.  $140^\circ$ .
  - b.  $260^\circ$ .
  - c.  $220^\circ$ .
  - d.  $300^\circ$ .
22. With standard connections between units when the transmitter is positioned at  $035^\circ$  and the differential transmitter is positioned at  $087^\circ$ , the receiver will be positioned at
- a.  $122^\circ$ .
  - b.  $308^\circ$ .
  - c.  $238^\circ$ .
  - d.  $052^\circ$ .
23. With standard connections between units, when the transmitter is positioned at  $065^\circ$  and the differential transmitter is positioned at  $350^\circ$ , what are the amplitude and phase of voltage across  $R_3$  in reference to the phase of voltage across the transmitter rotor?
- a.  $-45.0$
  - b.  $+45.0$
  - c.  $-36.8$
  - d.  $+36.8$
24. With standard connections and the differential transmitter on zero degrees when the transmitter is turned in either direction, the differential transmitter acts as a
- a. compensating device.
  - b. correcting device.
  - c. transformer-coupling device.
  - d. receiver unit.
25. With  $S_1$  and  $S_3$  reversed at the transmitter, the differential transmitter positioned at  $315^\circ$ , and the receiver positioned at  $125^\circ$ , what is the position of the transmitter?
- a.  $080^\circ$
  - b.  $235^\circ$
  - c.  $280^\circ$
  - d.  $190^\circ$

## ASSIGNMENT SHEET 6.17.1A

### SERVO FUNDAMENTALS

#### INTRODUCTION

The purpose of this assignment is to familiarize you with servo fundamentals appropriate for the AT, AQ, and AX ratings. Once this has been learned, you can acquire some principles and techniques that are useful and important in specific circumstances. It is important, first, to know the basic principles and then know when and how to modify them if necessary.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.80. SELECT, from a given list, the purpose of an electronic servo system.
- 12.4.81. SELECT, from a given list, the four error detecting devices.
- 12.4.82. SELECT, from a given list, the four requirements for a servo motor.
- 12.4.83. SELECT, from a given list of statements, the statement that describes the difference between a velocity servo and a position servo.
- 12.4.85. SELECT, from a given list of statements, the statement that describes the operation of an open-loop servo system.
- 12.4.86. SELECT, from a given list of statements, the statement that describes the operation of a closed-loop servo system.
- 12.4.87. SELECT, from a given list, three methods of damping.
- 12.4.88. SELECT, from a given list, the three classifications of damping.

#### STUDY ASSIGNMENT

1. Read Basic Electronics, Vol. II, NAVPERS 10087-C CNTT M699, Chapter 12, pages 214-223.
2. Read Information Sheet 6.17.1I "Servo Systems".
3. Review Notetaking Sheet 6.17.1N.
4. Complete Assignment Sheet 6.17.1A.

## STUDY QUESTIONS

1. What is a servomechanism?
2. What is the main purpose of a servomechanism?
3. The controlling device in a servo control system is designed to perform what function?
4. What are the response time requirements of a servomotor?
5. What error detection device is more often used in aviation?
6. The windings on the outer legs of the "E" transformer are wound series-opposing to provide what voltage out when the I-bar is centered?
7. What method of damping is more desirable?
8. A simple motor is made up of what component parts?
9. What is a rate generator?
10. What type of rotor is most often used in a rate generator?
11. What are the four requirements of a servo motor?
12. What are the four types of error detecting devices?
13. What are the three classifications of damping?
14. What is a closed-loop servo system?
15. What is an open-looped servo system?
16. What is the difference between a velocity servo and a position servo?

## ASSIGNMENT SHEET 6.18.1A

### SYNCHRO RESOLVERS

#### INTRODUCTION

The purpose of this assignment is to introduce you to synchro resolvers, their purpose, construction, and how they perform mathematical functions.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.73. SELECT, from a given list of statements, the statement that describes a synchro resolver's purpose, characteristics, and circuit operation as used in computers and control systems.
- 12.4.75. SELECT, from a given list of statements, the statement that describes the phase relationship between the primary and secondary windings at the electrical zero position.
- 12.4.76. CALCULATE the rectangular output voltage of a synchro resolver, given a polar input voltage.
- 12.4.78. CALCULATE the polar output voltage for a specified rectangular input to a synchro resolver.
- 12.4.79. SELECT, from a given list, the purpose of a sweep resolver.

#### STUDY ASSIGNMENT

- 1. Read Programmed Instruction "Synchro Resolver" CNATT-M150 (rev. 12-71).
- 2. Complete Assignment Sheet 6.18.1A.

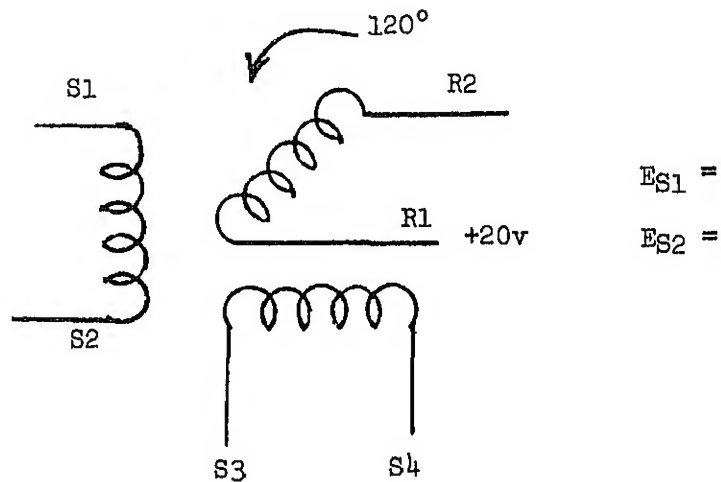
#### STUDY QUESTIONS

- 1. When changing from polar to rectangular form, the resolver is:
  - a. combining two vectors to form a resultant vector.
  - b. breaking down a vector to its two right angle components.
  - c. adding two vectors to form a resultant angle.
  - d. computing horizontal range.

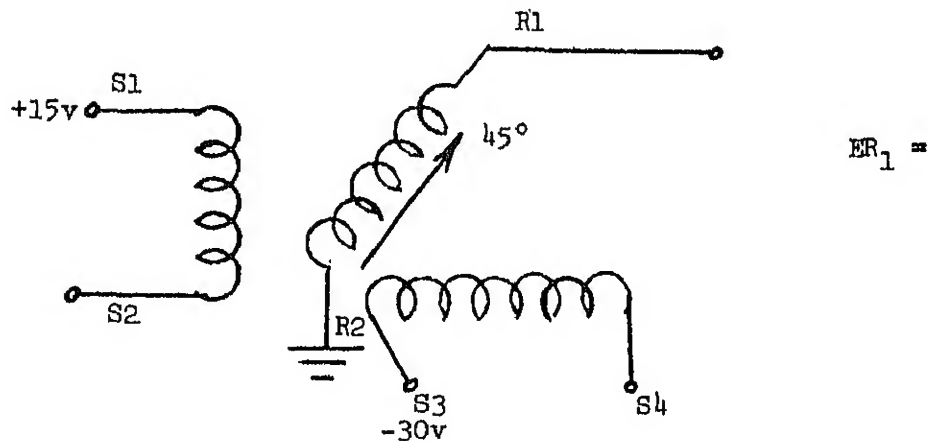
2. Which of the following is not a use of the synchro resolver?

- a. Perform coordinate conversion functions.
- b. Indicate an angular resultant.
- c. Provide two signals for an electromagnetic deflection system.
- d. Provide an output proportional to the error.

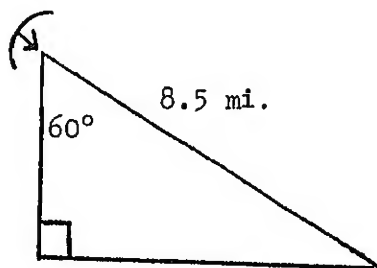
3. Compute the output voltage for  $S_1$  and  $S_3$ .



4. Compute the output voltage for  $R_1$ .



5. Compute the horizontal range and altitude for the bombing problem.



$R_h =$

$\text{Alt} =$



## ASSIGNMENT SHEET 6.19.1A

### DISPLAY CORRELATION

#### INTRODUCTION

The purpose of this assignment is to familiarize you with the appropriate controls and relays required to display the various modes and submodes of operation. Once this has been learned, you will further acquire principles and techniques that will be useful in troubleshooting the Indicator Video Unit (1400 unit).

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.89. SELECT, from a given list, the purpose and characteristics of a PPI scan.
- 12.4.90. SELECT, from a given list, the purpose and characteristics of a Bomb Director scan.
- 12.4.91. SELECT, from a given list of statements, the statement that describes the purpose and characteristics of a Fire Control scan at distances greater and less than 3500 yards.
- 12.4.92. SELECT, from a given list, the mode in which relay K-1404 is energized.
- 12.4.93. SELECT, from a given list, the purpose of B-1401.
- 12.4.94. SELECT, from a given list of statements, the statement that describes time sharing.

#### STUDY ASSIGNMENT

##### A. Read:

- 1. Aviation Fire Control Technician 3 & 2, NAVEDTRA 10387-B, Chapter 12, pages 309 through 317.
- 2. Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, NAVTRADEV P-2974-1, Dec. 1968, Sec. III, pages 3-54 through 3-60.

##### B. Study Notetaking Sheet 6.19.1N.

##### C. Complete Assignment Sheet 6.19.1A.



## STUDY QUESTIONS

1. What switches control the mode of operation of the radar?
  - a. S-1405, S-1401
  - b. S-1401, S-1406
  - c. S-1405, S-1404
  - d. S-1405, S-1406
2. What symbols are displayed in the FIRE CONTROL AUTOMATIC TRACK submode?
  - a. Range sweep, range circle, acquisition symbol, steering dot, target video, and artificial horizon line.
  - b. Range sweep, range circle, range notch, target video, artificial horizon line, and steering dot.
  - c. Range circle, range notch, target video, artificial horizon line, and steering dot.
3. In the TRACK submode of operation what is the purpose of R-140?
  - a. One look per second
  - b. 6 rpm
  - c. 0 to 6 rpm
  - d. Two looks per second
4. In the FIRE CONTROL AUTOMATIC SEARCH submode, what is the antenna scan rate?
  - a. 2
  - b. 3
  - c. 4
  - d. 5
5. How many ranges are displayed on the PPI indicator?
  - a. 2
  - b. 3
  - c. 4
  - d. 5
6. What is the sequence of the symbols generated by the A-gun?
  - a. Circle, Breakaway X, Steering Dot, Artificial Horizon Line
  - b. Circle or Breakaway X, Artificial Horizon Line, Steering Dot
  - c. Range Circle, Artificial Horizon Line, Steering Dot
  - d. Range Circle, Artificial Horizon Line, Steering Dot or Breakaway X

7. What is the function of R-1667 in the 12,000-yard SEARCH mode of operation?
  - a. Sets the amount of feedback in the reference oscillator
  - b. Adjusts the amount of delay for the delayed trigger
  - c. Adjusts gate width to 12,000-yard range
  - d. Positions the variable range marker
8. What positions the acquisition symbol vertically in the FIRE CONTROL AUTOMATIC SEARCH submode?
  - a. R-1460
  - b. R-1461
  - c. R-1477
  - d. R-1443
9. What condition energizes K-1501?
  - a. Power on
  - b. Breakaway
  - c. Acquisition
  - d. In-range
10. What is the purpose of the artificial horizon line?
11. Time sharing permits



## ASSIGNMENT SHEET 6.21.1A

### RANGE TRACK BLOCK DIAGRAM

#### INTRODUCTION

The purpose of this assignment is to familiarize you with the range track block diagram operation. Once you are familiar with this material, you will acquire some principles and techniques that are required for more advanced study.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.95. SELECT, from a given list, the function of the 1900 unit in the bomb director mode.
- 12.4.96. SELECT, from a given list, the function of the 1900 unit in the fire control auto search submode.
- 12.4.97. SELECT, from a given list, the function of the 1900 unit in fire control acquisition.
- 12.4.98. SELECT, from a given list, the function of the 1900 unit in the fire control auto track submode.
- 12.4.99. SELECT, from a given list, the purpose of DL-1901.
- 12.4.100. SELECT, from a given list, the function of the range strobe in the bomb director mode.
- 12.4.101. SELECT, from a given list, the purpose of the range strobe in the fire control auto track submode.

#### STUDY ASSIGNMENT

- 1. Read Aviation Fire Control 3 & 2, NAVEDTRA 10387-B. Chapter 12, pages 337-339.
- 2. Read Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Vol. I of II, NAVTRADEV P-2974-1, Dec. 1968, Section III, pages 3-61 through 3-73.
- 3. Review Notetaking Sheet 6.21.1N.
- 4. Complete Assignment Sheet 6.21.1A.

## STUDY QUESTIONS

1. The waveform out of Q-1922 is
  - a. a linear negative sawtooth.
  - b. a minimum of  $247.2\mu s$  in FIRE CONTROL mode.
  - c. used only in BOMB DIRECTOR mode.
  - d. applied to the cathode of CR-1926.
2. The output of Q-1907 is
  - a. positive and negative range strobes.
  - b.  $2\mu s$  in duration.
  - c. target video.
  - d. one microsecond, negative range strobe.
3. Maximum current flows through the range track error detector when
  - a. range strobes are present.
  - b. locked-on.
  - c. range strobes are not present.
  - d. the gate diodes conduct.
4. The output of the range track error detector represents
  - a. acceleration.
  - b. range.
  - c. velocity.
  - d. distance.
5. Bipolar video is used to
  - a. select a target.
  - b. operate coincidence gate.
  - c. range track.
  - d. angle track.
6. The negative range strobe is reduced to 1
  - a. at the input to Q-1907.
  - b. only during lock-on.
  - c. by swamping action of T-1901.
  - d. by CR-1906.

NOTE:  $\mu s$  = microseconds

## ASSIGNMENT SHEET 6.22.1A

### RANGE TRACK SCHEMATIC ANALYSIS

#### INTRODUCTION

The purpose of this assignment is to familiarize you with basic range tracking circuitry. Once this material is learned, you can acquire some principles and techniques that are useful and important in specific circumstances. It is important to first know basic principles; then, when and how to modify them.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.102. SELECT, from a given list of statements, the statement that describes the range strobe's circuit characteristics and development in the bomb director and fire modes of operation.
- 12.4.103. SELECT, from a given list, the functions of J-1906's output in the bomb director mode.
- 12.4.104. SELECT, from a given list, the function of J-1906's output in the fire control mode.

#### STUDY ASSIGNMENT

- 1. Read Aviation Fire Control 3&2, NAVEDTRA 10387-B. Chapter 12, pages 337-339.
- 2. Read Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Vol.I of II, NAVTRADEV P-2974-1, Dec. 1968, Section III, pages 3-61 through 3-73.
- 3. Review Notetaking Sheet 6.22.1N.
- 4. Complete Assignment Sheet 6.22.1A.

#### STUDY QUESTIONS

- 1. What is the minimum pulse width of the signal from Q-1924 in the Bomb Director mode?
  - a. 494.4 microseconds
  - b. 247.2 microseconds
  - c. 1,000 microseconds
  - d. 35 to 45 microseconds

2. What is the output of J-1906 used for in the Fire Control Track submode?
  - a. Positions the range cursor
  - b. Positions the range notch
  - c. Positions the acquisition symbol
  - d. Controls range circle size
3. Bipolar video is
  - a. used in the TRACK submode.
  - b. sent to the indicator display.
  - c. created by DL-1902.
  - d. used in the SEARCH submode.
4. In the TRACK submode, as range decreases the
  - a. collector of Q-1912 becomes more positive.
  - b. emitter of Q-1912 becomes more negative.
  - c. range strobe occurs further from time zero.
  - d. range strobe occurs closer to time zero.
5. With target video and the range strobe coincident, the radar will not lock on. The possible cause could be
  - a. Q-1907 open.
  - b. Q-1906 open.
  - c. C-1923 shorted.
  - d. Q-1904 open.
6. Because of the action of K-1901,
  - a. C-1923 and C-1925 are utilized in the FIRE CONTROL mode.
  - b. C-1923 and C-1925 are utilized in the BOMB DIRECTOR mode.
  - c. C-1922 and C-1924 are utilized in the FIRE CONTROL mode.
  - d. C-1922 and C-1924 are utilized in the BOMB DIRECTOR mode.
7. DL-1901 is used to
  - a. delay the video.
  - b. shape the video.
  - c. delay the range strobe.
  - d. shape the range strobe.
8. Where is the pulse width of the negative strobe reduced to one microsecond?
  - a. At the input to Q-1907
  - b. At DL-1902
  - c. In the secondary of T-1901
  - d. At the collector of Q-1907.

9. The pulse width of the range strobe can be varied by what component?
- a. R1999
  - b. R1985
  - c. R1974
  - d. R1914
10. How is the acquisition signal inhibited during the Bomb Director mode?
- a. Only a small section of the circuit is used.
  - b. Due to the de-energized contacts of K1901.
  - c. The range strobe and target cannot be coincident in Bomb Director.
11. What is the purpose of CR-1923?
- a. Limiter
  - b. Clamper
  - c. Bootstrap disconnect diode
  - d. Half-wave rectifier
12. What component is the primary controlling element of the bootstrap sawtooth pulse width in the Fire Control mode?
- a. C1923
  - b. C1924
  - c. C1925
  - d. C1922
13. The 11D13 Radar Trainer has constant lock-on. A possible cause could be:
- a. Q-1934 open
  - b. Q-1903 open
  - c. F-1901 open
  - d. Q-1913 open
14. When the range strobe is present at the cathode of CR-1901, Q-1904 will operate in what class of bias? \_\_\_\_\_.
- a. Class A
  - b. Class C
  - c. Class B
  - d. Class AB





ASSIGNMENT SHEET 6.23.1A  
ANGLE TRACK CIRCUIT ANALYSIS

INTRODUCTION

The purpose of this assignment sheet is to familizarize you with the concepts of angle tracking a target. This information is important and will aid you in the Unit 7 troubleshooting lab.

LESSON TOPIC LEARNING OBJECTIVES

- 12.4.105.     SELECT, from a given list, the purpose of the angle track circuits.
- 12.4.106.     SELECT, from a given list of statements, the statement that describes the difference between the asimuth and elevation detection circuits.
- 12.4.107.     SELECT, from a given list of statements, the statement that describes what the polarity and amplitude of the error signals indicate.
- 12.4.108.     SELECT, from a given list, the purpose of nutation in a radar system.
- 12.4.109.     SELECT, from a given list of statements, the statement that explains why several stages of amplification are necessary in the elevation channel.

STUDY ASSIGNMENT

- 1.   Read Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Device 11D13A, NAVTRADEV P-2974-1 December 1968, Section III, pages 3-70 through 3-73.
- 2.   Aviation Fire Control Technician 3&2, NAVEDTRA 10387-B, Chapter 12, page 339.
- 3.   Review Notetaking Sheet 6.23.1N.
- 4.   Complete Assignment Sheet 6.23.1A.

STUDY QUESTIONS

- 1.   What is the phase relationship between azimuth and elevation?
  - a.   180 degrees out-of-phase
  - b.   90 degrees out-of-phase
  - c.   in phase
  - d.   45 degrees out-of-phase

2. Q1917's output is positive when the target is
  - a. left of center.
  - b. below center.
  - c. right of center.
  - d. above center.
3. The output of Q1916 is negative when the target is
  - a. left of center.
  - b. below center.
  - c. right of center.
  - d. above center.
4. The elevation channel must use amplifiers in order to overcome the effect of \_\_\_\_\_ on the weight of the antenna.
5. The direction of antenna movement is determined by the \_\_\_\_\_ of the azimuth and elevation channels, while the amount of movement is determined by the \_\_\_\_\_ of those outputs.

## ASSIGNMENT SHEET 6.24.1A

### RADAR INDICATORS

#### INTRODUCTION

The purpose of this assignment is to familiarize you with the basic types of radar indicators and the characteristics of each. Once this has been learned, you can acquire some principles and techniques that are useful and important in specific circumstances. It is important, first, to know the basic principles and then to know when and how to modify them if necessary.

#### LESSON TOPIC LEARNING OBJECTIVES

- 12.4.110. SELECT, from a given list of components, the ones which are required for a cathode-ray tube.
- 12.4.111. SELECT, from a given list, the two types of cathode-ray tubes.
- 12.4.112. SELECT, from a given list, the purpose of the aquadag coating.
- 12.4.113. SELECT, from a given list, the two types of modulation used with CRT's.
- 12.4.114. SELECT, from a given list of statements, the statement that describes the information derived from a PPI scan.
- 12.4.115. SELECT, from a given list of statements, the statement that describes the information obtained from the B-scan indicator.
- 12.4.116. SELECT, from a given list of statements, the statement that describes the information derived from the B-gun in the Fire Control submodes.
- 12.4.117. SELECT, from a given list of statements, the statement that describes the type of presentation used in bombing radar.

#### STUDY ASSIGNMENT

1. Read chapter 12, pages 312 through 317 in NAVEDTRA 10387-B, Aviation Fire Control Technician 3 & 2.

2. Read Section III, pages 3-26 through 3-32 in NAVTRADEV P-2974-1, Maintenance Handbook for Basic Fire Control Radar Maintenance Training Sets, Devices 11D13 and 11D13A, Dec 1968.
3. Read Information Sheet 6.24.1I.
4. Complete Assignment Sheet 6.24.1A.

#### STUDY QUESTIONS

1. All CRT's contain
  - a. deflection plates.
  - b. deflection coils.
  - c. fluorescent screen.
  - d. accelerating anode.
2. On the screen of a PPI-scope, target signals appear as
  - a. dark spots.
  - b. notches.
  - c. pale shadows.
  - d. bright spots.
3. On a C-scope, the position of a target on the scope represents the target's
  - a. bearing and range.
  - b. elevation and range.
  - c. bearing and elevation.
  - d. bearing, elevation, and range.
4. The horizontal position of the vertical trace on a B-scope represents the
  - a. range selected.
  - b. speed of antenna rotation.
  - c. direction the antenna is pointing.
  - d. direction the aircraft is heading.
5. PPI-scan sweep
  - a. rotates 360°.
  - b. rotates with the antenna.
  - c. indicates range and bearing.
  - d. all the above.

6. The type of scan which gives range and bearing information is the
  - a. A-scan.
  - b. B-scan.
  - c. C-scan.
  - d. E-scan.
7. A modified "B" scan has
  - a. distortion at the top.
  - b. distortion at the bottom.
  - c. a good navigation presentation.
  - d. range information only.
8. The information presented in both search and track presentations is artificial horizon,
  - a. targets.
  - b. targets, steering dot.
  - c. targets, range circle.
  - d. only.
9. Range is represented on the B-scope by
  - a. horizontal deflection.
  - b. vertical deflection.
  - c. a dot on the scope.
  - d. a circle on the scope.